

below the sinus of the seventh sternite (VII. st.) is narrower in *tripectinata*, and the lobe above the sinus longer than the lower lobe, the sinus therefore being much deeper in that species. The eighth tergite is divided by an apical incision into a broad setose upper lobe and a narrower and naked lower lobe in both species. The upper lobe, however, bears more bristles in *tripectinata* both on the outer and inner surfaces, and the bristles placed further proximad on the eighth tergite are also more numerous in *tripectinata*. The eighth sternite, on the contrary, has more bristles at the apex in the new species.

Length (mounted specimen, somewhat contracted) 3.5 mm.

One female from 23 miles S.E. of Ta-t sien-lu, 7500 ft., off *Sciurotamias davidianus consobrinus* M.-Edw.

20. Contributions to the Anatomy of the Anura. By FRANK E. BEDDARD, M.A., F.R.S., F.Z.S., Prosector to the Society.

[Received December 28, 1910: Read March 7, 1911.]

(Text-figures 125-133.)

I. SOME NOTES UPON THE FROG *MEGALOPHRYS* (*LEPTOBRACHIUM*) *FEÆ*.

Of this species* living examples have been recently, and are at the moment, exhibited in the Society's Gardens. The Frog was later described by Mr. G. A. Boulenger† as of the genus *Leptobrachium*, but originally‡ referred to the genus *Megalophrys*, to which all the Pelobatidæ belonging to the former genera *Megalophrys*, *Xenophrys*, and *Leptobrachium* are now§ by him referred. In dealing with certain points in the anatomy of *M. feæ*, I shall have occasion to refer to the mutual likenesses and unlikenesses between this and other species of the family to which I have already paid some attention||.

The external characters have been so fully described by Mr. Boulenger in the several papers quoted below, that little remains to be said under this heading. There is, however, one point to which I may refer. In dealing with *Xenophrys monticola* and other forms, I have described¶ and figured a glandular patch upon the thigh which is very characteristic of these Frogs. I can find no trace of this structure in *Megalophrys feæ*; and it is thus

* The specimens were, as I understand, identified by Mr. G. A. Boulenger.

† Ann. Mus. Civ. Genova, vol. vii. 1889, p. 750.

‡ *Ibid.* vol. iv. 1887, p. 512. For other references see Mr. Boulenger's paper in the P. Z. S. quoted below.

§ P. Z. S. 1908, p. 407.

|| P. Z. S. 1907, p. 324, and *ibid.* 1907, p. 871. The latter paper deals with *Megalophrys montana*, "*Xenophrys monticola*," "*Leptobrachium hasseltii*," and, incidentally, with *Megalophrys nasuta*, which is more fully described in the former paper.

¶ P. Z. S. 1907, p. 879, text-fig. 230.

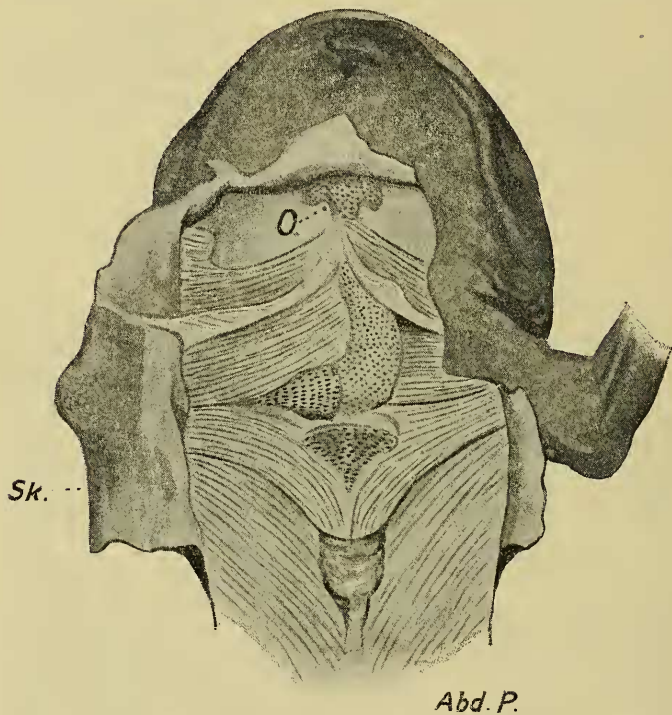
evidently not a distinguishing feature of the genus, as opposed to *Pelobates*, as I had been disposed to think.

I now direct attention to other points in the anatomy of this species, and more especially to those which are already known to be of systematic importance. This, indeed, has been my object rather than to attempt a more comprehensive anatomical account.

§ *Sternum.*

In considering the mutual affinities of four species of *Pelobatidæ* described by me in a former paper*, I had laid some stress

Text-fig. 125.



Ventral view of anterior part of the body of *Megalophrys fœæ* partially dissected.

Sk. Skin reflected. *Abd.P.* Pectoralis abdominalis. *O.* Omosternum.

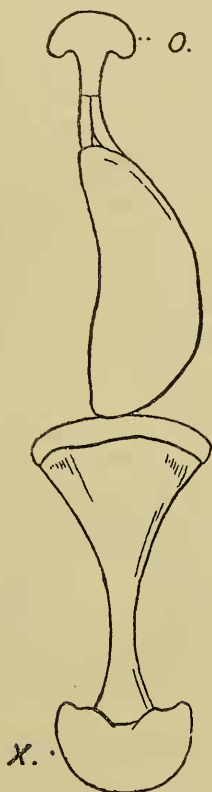
The cartilaginous right overlapping epicoracoid is dotted; the bony coracoid and shaft of sternum are marked by short lines.

upon the proportions visible in the total length of the body on the one hand, and of the sternum and sternal region on the other.

* P. Z. S. 1907, p. 891.

The measurements which I have just made upon *Megalophrys feæ* confirm the value of the results which I obtained from the former series of measurements. Of *Megalophrys feæ* I ascertained the following measurements:—length of body from snout to cloacal aperture 95 mm. ; length of sternal region from anterior

Text-fig. 126.

Sternum of *Megalophrys feæ* from the ventral surface.

O. Omosternum. X. Xiphisternum.

Between the omosternum and the shaft of the sternum is seen the right, overlapping, epicoracoid.

end of omosternum to posterior end of sternum 30 mm. ; length of sternum proper 17 mm. Considering the body-length as 10, the other measurements will be respectively 3.2 and 1.8. The proportions therefore are, it will be observed, exactly as in the species *Leptobrachium hasseltii*. In a second specimen the

proportions were the same, the Frog being about 1.5-2 mm. longer with a corresponding increase of length of from .5-1 mm. in the sternal measurements.

It is, as is well known, the general rule among the Arciferous Batrachia Salientia that the right epicoracoidal cartilage should overlap the left ventrally. This was the case in three out of the four examples of *Megalophrys feæ* which I have had the opportunity of examining (see text-fig. 125, p. 394). In the fourth, however, the converse condition occurred. It may be that this individual is of a different species; and yet I cannot find from a study of Mr. Boulenger's table of classification * any grounds for identifying this individual with other species described by him. It is, however, rather different in appearance from the other Frogs; its build is more slender, the pelvic width is less, and the dorsal depression is much deeper and with a more arched upper bordering ridge. Other depressions upon the head are also more marked. I could not, however, detect any other external differences. All the four specimens, I should observe, are males.

In view of the fact that the *omosternum* is already known to differ among the species of *Megalophrys* (contrast, for example, *M. montana* and *M. nasuta*), it is important to note the condition in *Megalophrys feæ*. In this species (see text-fig. 126) it is, in fact, quite as well-developed as in *Megalophrys nasuta*, from which, however, it differs in various details. Its total length is 8 mm., which represents a size proportionately equal to, or not very different from, that of *Megalophrys nasuta*. The epicoracoids are firmly attached to the basal portion of the omosternum, which shows a trace of its double origin (? from the two epicoracoids) in that it is divided longitudinally by a white fibrous seam. This part of the omosternum is, in fact, precisely as is figured by W. K. Parker † in *Pseudis*. In addition to this there is a distal piece which is single and not divided longitudinally, but which is divided off by a seam from the basal portion of the omosternum. This piece is cheese-cutter-shaped, as shown in text-fig. 126.

§ *The Hyoid and its Musculature.*

The *hyoid* cartilages and bones, as I have already pointed out, present some differences among the various species of *Megalophrys* (s. l.). I have therefore attempted a careful study of this portion of the skeleton in *Megalophrys feæ*. The basal cartilage of the hyoid has the usual broad form found in the allies of this species; of this the *processus anteriores* are bowed inwards anteriorly almost to meet in front of the exit from the hyoid region of the hyoglossal muscle. This condition of the processes in question has apparently, as I have already pointed out, some systematic importance. The hyoglossal sinus, thus nearly converted into a

* P. Z. S. 1908, p. 410.

† 'A Monograph of the Shoulder-Girdle,' Ray Soc. Publ. 1868, pl. vi. fig. 7.

foramen, is of much greater diameter than the hyoglossal muscle which passes through it. The inconvenience which might thus result is obviated by the existence posteriorly of a tough translucent membrane, which largely occupies the hinder part of the sinus by stretching across it. It has a clean semicircular edge in front over which the muscle plays. I have been unable to find any anterior cornua of the hyoid, which appears to be absent, at any rate as a discrete cartilage, in this group of Frogs. But the lateral foramina are present and correspond, as I imagine, to similar foramina in *Pelodytes punctatus*, the development of which has been worked out by Ridewood*. In *Megalophrys fée* they transmit in the same way the glossopharyngeal nerves, than which they are only just larger. The strongly ossified thyrohyals have the usual elongated hourglass shape. The distal cartilaginous epiphysis of each of these bones has very much the shape and direction that it has in *Xenophrys monticola*, to my figure of which I refer below †.

The musculature of the hyoid does not appear to me to present any particular features of interest as compared with allied forms. The *hyoglossus* did not show the twisted rope-like strands that I have observed and described in allied forms. Each muscle arose solely from the inner and lower border of the thyrohyal bone, and not at all from the flat surface of that bone.

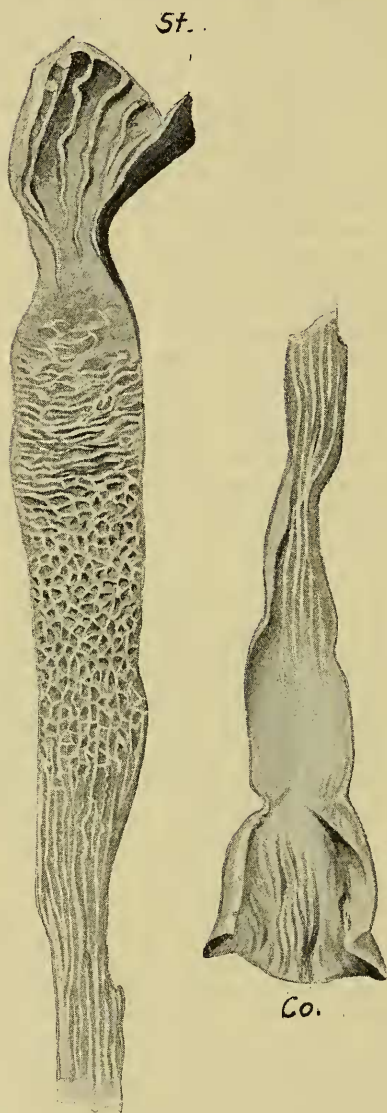
§ Alimentary Canal.

The accompanying drawing (text-fig. 127, p. 398) of the alimentary canal of *Megalophrys fée* may be compared with that of *Breviceps* upon a later page (p. 407). The stomach of the *Megalophrys* is longitudinally ridged by thick ridges, of which there are eight in the middle of that organ. Of these only three survive until the opening of the stomach into the duodenum; the others die away and cease to be ridges. The *intestinal tract* measures 104 mm., and is to be divided into a very short duodenum, a wider ensuing region, and then a narrower ileum which opens into the large intestine. The regions are, in fact, quite as in *Breviceps*. The length of the three different regions of the small intestine are 6, 42, and 57 mm. respectively. Although it will be observed that these measurements do not tally exactly with the total length of the small intestine, it will be noted that they are only divergent by 1 mm. As the measurements of the different regions of this gut were made quite independently and without any concurrent reference to the total length of the small intestine, I leave them at the figures which I have given. It will be observed that these proportions are very different from those exhibited by *Breviceps*. There are also certain differences in the ridges which

* "On the Structure and Development of the Hypobranchial Skeleton of the Parsley Frog (*Pelodytes punctatus*)," P. Z. S. 1897, p. 577.

† P. Z. S. 1907, p. 898, text-fig. 238.

Text-fig. 127.



The alimentary tract of *Megalophrys feæ* from the middle of the stomach to the middle of the colon laid open and divided into two portions, an anterior (to the left) and a posterior (to the right of the figure).

St. Stomach. Co. Colon.

line the gut. But the general plan is the same. The first region, which is so very short, is marked off from the stomach by a sudden diminution in the thickness of its walls. The lining-membrane is at first smooth and is later covered by ridges forming a reticulum. These gradually become the circular folds like those of *Breviceps*; but the region of the gut where the circular folds occur is very limited and not more than 10 mm. long. The terminal and narrower portion of the gut is marked by about ten longitudinal folds, the transition between which and the transverse folds is a network.

These folds are at first permanent and cannot be removed by stretching the gut; later they exist, but can be removed by stretching. Finally, this region of the gut becomes smooth before its opening into the large intestine. The latter is at first smooth but later has longitudinally running folds.

The *liver* viewed from the ventral surface is seen to consist of a larger left lobe and a much smaller right lobe, between which the large gall-bladder is very obvious and extends back a good way beyond the edge of the liver into the abdominal cavity. Under the large left lobe lies a smaller lobe, which is of about the same size as the right lobe and is continuous with it under the pericardium and membrane of the gall-bladder.

Lying above the viscera the large *subvertebral lymph-space* is very obvious. Its relations to the body-wall and to adjacent viscera are as follows:—The sac is bifurcate in form and extends forward beyond the anterior end of the kidney, but not so far as to the anterior end of the ileum. The two bifurcations of the sac lie on either side of the ileum, and the sac therefore does not extend so far forward where it lies upon the iliac musculature as it does right and left of this region. It does not extend ventrally to the kidney, but separates this viscus dorsally from the dorsal body-wall. Posteriorly it overlies the bladder, which is firmly attached to its wall.

§ *Esophageal Muscle.*

This visceral skeletal muscle is so important and characteristic in *Megalophrys* and its allies that its consideration demands a section to itself. It is rather thin and does not overlap the kidney, which lies entirely posteriorly to it. It does, however, overlap the anterior part of the ileum. I have figured the muscle in *Megalophrys montana* * as extending far back, in fact so that it overlaps the sacral vertebra transverse process at its comparatively narrow origin from the centrum. This was not the case with *Megalophrys feæ*, where the muscle is therefore less extensive. It is, however, large when compared with that of Frogs of other families. It appears to differ but little in details from the muscle of *Megalophrys nasuta* †.

* P. Z. S. 1907, p. 886, text-fig. 233, m.

† Loc. cit. p. 876, text-fig. 229, b.

§ *The Larynx.*

I do not here figure the larynx of *Megalophrys feæ* because it agrees substantially with that of other Oriental Pelobatidæ figured elsewhere by myself *. There are, however, as I have shown in the memoir referred to, at least specific differences among the Pelobatidæ. I find that *Megalophrys feæ* agrees very closely with *Xenophrys monticola* and thus differs from *Leptobrachium hasseltii*. The hypopharyngeal processes of the cricoid cartilages are well developed and remain separate, *i. e.* are not united into a single bar. A delicate semicircular bronchial cartilage is quite obvious attached or close to the anterior extremity of the cricoid cartilage.

§ *Muscles of Ventral Surface.*

In removing the skin of the ventral surface in the pectoral and cephalic region the septa bounding the lymph-spaces in that region come into view. I have already figured these in *Xenophrys monticola* †, and the corresponding septa in *Megalophrys feæ* appear at first sight to be much the same. The posterior of the two is rather more chevron-shaped in the line of its attachment perhaps; but this may be a matter of varying tension. On the other hand, the same chevron line occurs in *Leptobrachium hasseltii* ‡. In *Megalophrys feæ* the line of insertion of the wall of the subcutaneous lymph-sac does not extend obliquely downwards on to the pectoralis abdominalis as in *Leptobrachium*. There appears to be no invasion of this membrane by muscular fibres, and in this the present species agrees with the two just referred to.

The anterior wall of the pectoral or thoracic lymph-sac has been figured by myself as a single wall in the two species which are above referred to, and as arising from the edge (posterior) of the submaxillaris muscle. I find precisely the same origin in *Megalophrys feæ*; but there is in addition another membrane rising from the muscular surface behind this line which joins the first-named to be inserted in common with it on to the skin. This tent-like arrangement leads to the formation of an additional sac, which is obviously triangular in section. I may, perhaps, have missed something of the same kind in the other Megalophryid Frogs which I have examined. Examined microscopically, the two walls of membrane showed nothing but white fibrous connective-tissue; there was no trace whatever of any muscular invasion, and, indeed, the edge of the submaxillaris could be plainly seen to give off no fibres into the membrane. Inasmuch as I observed this double wall in four examples of the Frog, there can, I think, be little doubt of its being the normal arrangement.

A further exploration of this cavity shows that it is not a lymph-sac at all; it is the gular sac which is thus intruded

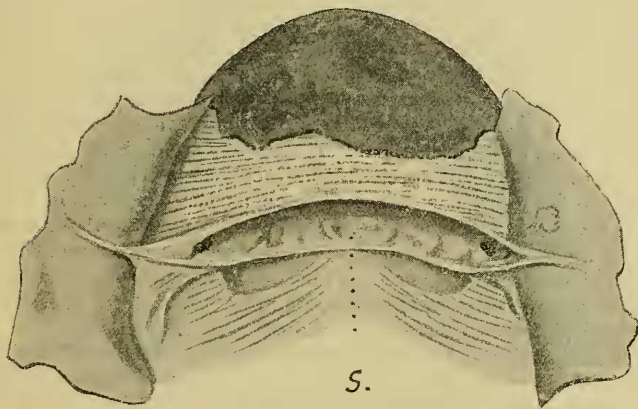
* P. Z. S. 1907, p. 898, text-fig. 238, p. 899, text-fig. 239, p. 902, text-fig. 240.

† P. Z. S. 1907, p. 882, text-fig. 231.

‡ *Loc. cit.* p. 884, text-fig. 232.

between two subcutaneous lymph-sacs. At each corner near to the angle of the jaw is the orifice into the mouth-cavity, through which a probe was, of course, passed to show that the aperture did actually communicate with the mouth-cavity. On opening the mouth the orifices in question were very plainly visible posteriorly. It will be noted that the gular sacs in this Frog, instead of being separate sacs as in *Rana*, are entirely confluent and form one median ventral sac, which is shown in the accompanying text-figure (text-fig. 128), as in *Rhinoderma darwini**. There is no trace of a division in the middle line of the body between the right and left sacs; they obviously form a continuous single narrow sac lying just behind the subhyoideus muscle opening at

Text-fig. 128.

Gular sac (S.) of *Megalophrys feae*.

On each side the dark shaded orifice into the buccal cavity is seen.

either extremity into the mouth-cavity. The walls of the gular sac are rather extensive; but, as has been already mentioned, they are inserted in common on to the skin. This obviously would hinder any very great dilatation of the sacs. Furthermore, they could not extend in a dilated condition very far back along the body, for the septum between the lymph-sacs in the pectoral region would clearly prevent this. In *Rhinoderma*, on the other hand, "the main portion of the sac hangs free" †.

As to the musculature proper, the *rectus abdominis* shows no definite traces that were at all apparent to me of *inscriptiones tendineae*, which seems to be rather an important difference from its nearest allies.

* Cf. Howes, "Notes on the Gular Brood-pouch of *Rhinoderma darwini*," P. Z. S. 1888, p. 231.

† Howes, *loc. cit.* p. 234.

The *pectoralis abdominalis* is not very extensive; it reaches back for about one-third of the distance between the end of the sternum and the symphysis pubis.

The musculature in the sternal region (see text-fig. 125, p. 394) does not entirely cover the bones and cartilages of the shoulder-girdle. The right epicoracoidal cartilage, which greatly overlaps ventrally the corresponding cartilage of the left side, is for the greater part bare of muscle. A large portion of the right coracoid bone and the triangular bony base of the sternum were also uncovered by muscle. In a second specimen, however, the pectoralis did extend over the triangular basal region of the sternum.

The *rectus abdominis* continues forward anteriorly after the origin of the pectoralis abdominalis and lies to the side of the sternum, separated from it, however, by a much narrower muscle which arises from the shaft of the sternum, and which I shall again refer to as a portion of the sternohyoideus. At the anterior end of the dagger-shaped sternum a portion of the rectus abdominis is inserted upon the lateral transverse extension of the "handle" of the "dagger." The rest passes onwards anteriorly and becomes a part of the sternohyoideus. I did not observe in the present species a tendinous connection of the rectus with the edge of the coracoid such as that figured in *Xenophrys monticola* *. Nor did I note any fibrous lateral expansion of the sternum, such as occurs in the species just mentioned, covering over the innermost section of the sternohyoideus muscle. If such a membrane were present it must have been excessively thin and delicate to have escaped observation.

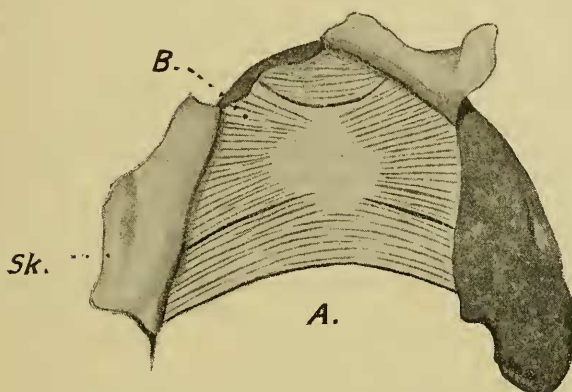
I have mentioned that in *Xenophrys* no superficial *sternoradialis* is visible; in the present species it is only superficial—and then covered by fascia—for a very short distance after its origin from the omosternum. It is thereafter covered by the pectoralis. The strong tendon was followed to its insertion, and there is thus no doubt about the presence of this important muscle in *Megalophrys fœv.* As the fascia in question is continuous with the pectoralis, the sternoradialis may be said to be completely covered by that muscle. The two (anterior and posterior) portions of the *pectoralis sternalis* are very distinct at their origin, on the right side at any rate, by reason of the exposed bony end of the coracoid which separates them. The origin of the pectoralis sternalis posterior extends about halfway down the bony shaft of the sternum, but appears to vary in individuals, in the extent of its attachment to the sternum, as the text-figure (text-fig. 125) referred to above shows.

The throat musculature of *Megalophrys fœv* is exhibited in the accompanying drawing (text-fig. 129). There are no prominent differences from the conditions of the corresponding muscles

* P. Z. S. 1907, p. 893, text-fig. 236, a.

observable in other Megalophryidæ. The *submentalis* is large and conspicuous anteriorly. In the middle of the area occupied by the two succeeding muscles is a tendinous sheet quite similar to that which I have figured in *Leptobrachium hasseltii**. This is concerned with the *subhyoideus* as well as with the *submaxillaris* muscle. The fibres of the latter radiate a good deal from the central tendon—that is to say, they do not cross the jaw space

Text-fig. 129.

Ventral musculature of the throat of *Megalophrys fœa*.

Sk. Skin reflected. A. Subhyoideus. B. Submaxillaris.
Anteriorly to the latter is the submentalis.

evenly and in parallel lines from side to side, being only interrupted by the central tendon. The line of demarcation between the submaxillaris and subhyoideus is very distinct indeed. The submaxillaris, it should be remarked, completely covers over the submentalis, though it thins off in this anterior region of the throat.

§ Musculature of the Dorsal Surface.

The *depressor mandibulæ* seems to be very much as in *Rana* and is a stout muscle firmly attached in front to the skull, where it shows thicker in transverse section; it completely covers the scapula together with the *latissimus dorsi*, the two forming a continuous sheet of muscle. I have not mentioned the depressor mandibulæ in my two former papers upon the anatomy of the Pelobatidæ, and therefore take this opportunity of asserting its presence in the genus *Megalophrys*.

* "Contributions to the Knowledge of the . . . Pelobatidæ," P. Z. S. 1907, p. 884, text-fig. 232.

II. FURTHER NOTES UPON THE GENUS *BREVICEPS*.

Nearly three years ago I communicated to the Society some notes upon the anatomy of an African Frog belonging to the genus *Breviceps*, which I identified with the species *B. verrucosus* *. I am now of opinion that three Frogs upon which I reported on that occasion are not to be referred to this species, which I have lately examined. The specimens of *Breviceps verrucosus* and of *B. gibbosus*, which were exhibited at the Society's Gardens some years since, and of which several have been preserved in alcohol, are distinctly different from those to which I had devoted my attention in the paper already quoted. They are much more spherical in outline, agreeing with a published figure of *B. verrucosus* † and of *B. mossambicus* ‡. The examples formerly studied by myself were much longer in proportion and of a squarer outline. Furthermore, the examples of *B. verrucosus* and *B. gibbosus* in the possession of the Society are more tubercular upon the surface of the body. I am, however, quite unable to suggest the species to which the specimens dissected by myself in 1908 are to be referred. I cannot at any rate refer them to Mr. Boulenger's recently described *Breviceps macrops* §, for that species is abnormal (for *Breviceps*, though more normal when compared to other Frogs) by reason of the relatively large head and eyes. *Breviceps pentheri* of Werner || is quite too small a species to be confused with that to which I now refer, although the latter is considerably smaller than either *B. verrucosus* or *B. gibbosus*. The latter are hard to separate, as Mr. Boulenger has pointed out. A sixth species, *B. adspersus* ¶, appears to me to be too briefly described to permit of its identification with either the species with which I am now, or that with which I was, concerned.

The present contribution to our knowledge of this genus *Breviceps* is based upon the examination of four examples given to me by Mr. Purcell, who was so good as to have them collected in the Cape Colony. These seem to me to belong either to *B. gibbosus* or *B. verrucosus*, which I cannot differentiate to my own satisfaction and which are in any case very closely allied. Through the kindness of Mr. Purcell they were very well preserved for dissection purposes, and I am thus able to add something to the existing knowledge of *Breviceps*. I have already mentioned a few external differences between the present species and those which I dissected in 1907. I shall point out in the course of the following pages certain anatomical differences.

* Rapp. Arch. f. Nat. 1842, p. 291.

† Steindachner, Reise der Novara, Amphibien, Wien, 1867, pl. v. fig. 3.

‡ Peters, Reise nach Mossambique, Amphibien, Berlin, 1882, pl. xxv. fig. 2.

§ Ann. & Mag. Nat. Hist. xx. 1907, p. 46.

Mr. Boulenger remarks that, "Unlike *B. gibbosus*, *B. macrops* does not cover itself with a viscous secretion when alarmed." The species upon which I report in the present paper showed in one individual a thick mass of secretion on the body.

|| Zool. Anz. xxii. 1899, p. 116; the species is 15 mm. long.

¶ Peters, Reise nach Mossambique, Amphibien, Berlin, 1882.

between these members of the same genus. On the other hand, I am able to confirm certain structural features of the genus as formerly described by myself by finding an identical arrangement in these examples of *B. gibbosus*.

§ *Genito-urinary Organs.*

The *testes*, *fat-bodies*, and *kidneys* of *Breviceps gibbosus* do not altogether agree in their characters with my former description.

There is no doubt that the vasa efferentia of the testes are numerous, as is the general rule among the Anura. This fact I am clear about. So obvious are the several parallel sperm-ducts issuing from each testis, that I cannot understand how I can have been in error in describing only a single duct in the smaller species of *Breviceps*, if, that is to say, I was in error. Moreover, in *Breviceps gibbosus* the ureter arises from the lower corner of the kidney, and not from rather higher up as I have figured it in *Breviceps* sp.* The two kidneys are nowhere fused together in the middle line. It is worth recording that the fat-bodies have but few finger-like processes; I found two and three in one specimen and three and four in another. But these structures are known to vary.

§ *Respiratory Organs.*

The *lungs* of *Breviceps gibbosus* present several features of interest. Each lung itself (in the contracted condition in which it appears in the alcohol preserved specimens) is broader at the base and narrows towards the free abdominal extremity. It is important to notice that both extremities of the lung are free and that the bronchus enters that organ at about the second third of its entire length. The lung is thus not merely a sac dependent from a rudimentary trachea. Furthermore, two bronchi are very plainly differentiated. Each is, in fact, about half as long as the lung (contracted, of course) into which it opens. It is proportionately wide and enters the lung at right angles to the long axis of the latter viscus. Its walls are membranous and translucent and I could detect no cartilages. The pulmonary ligament fixing the lung to the dorsal middle line extends along the whole of the bronchus and just on to the lung.

If I have not in any way misread the conditions which obtain in the species of *Breviceps* † dissected three years since, that species shows considerable differences from *Breviceps gibbosus* in the relations of the *œsophago-pulmonary* muscle ("diaphragm"). There are, however, also points of agreement between the two sets of individuals. For instance, the muscle arises in both in the same way from a vertebral transverse process nearly in common with the transverso-scapularis. Furthermore, in both cases the

* P. Z. S. 1908, p. 38, text-fig. 13.

† *Loc. cit.* p. 27, and text-fig. 7, p. 28.

œsophago-pulmonary muscle is closely associated in function with the hindermost of the petrohyoid muscles.

Here, however, the principal resemblances end and there remain certain important differences.

The most important of these points of difference is that the muscle which we are discussing has no relations whatever, except those of contiguity, to the respiratory organs. I believe that I can assert this fact with confidence; but I have no reason to doubt the essential accuracy of my description of the other species of *Breviceps*. The difference in this particular may be due to the extraordinary development of the bronchi in *Breviceps gibbosus*. In this species, the insertions of the œsophageal muscle and of the hindermost petrohyoideus are as follows:—Two muscles are seen to be inserted on to the ventral surface of the œsophagus, fanning out somewhat at their insertion, which falls short of the middle ventral line. It is perfectly clear, when these muscles are followed back, that they have no attachment (distal) other than to the surface of the œsophagus. The œsophageal muscle is the larger of the two, and it partly forms an arch over the œsophagus which is not attached to it; some of its fibres, that is to say, run from one vertebral transverse process to the corresponding one upon the opposite side of the body. The rest are inserted upon the œsophagus; but they pass underneath the fibres of the petrohyoideus and are inserted laterally to them. The insertion of the petrohyoideus upon the œsophagus appears to me to be quite as extensive and important as is that of the œsophageal muscle itself.

§ *Alimentary Tract.*

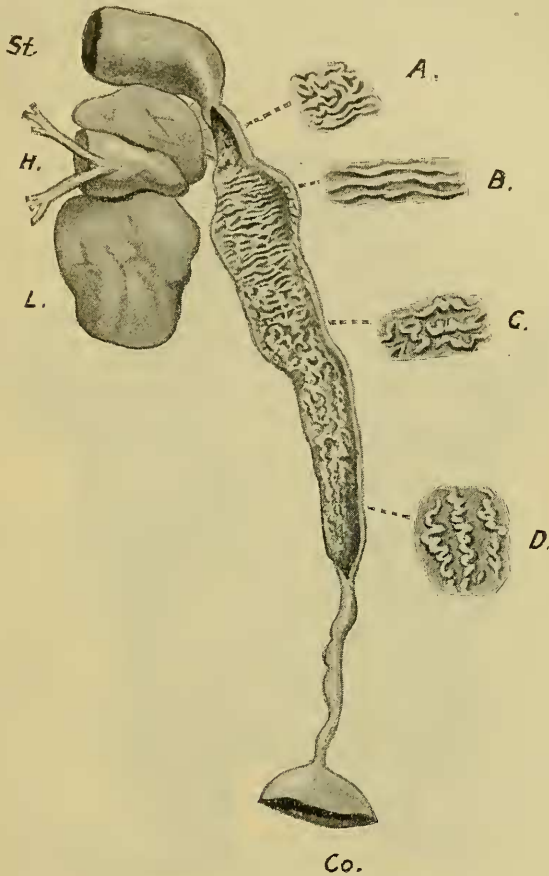
I have had represented in the accompanying text-figure (text-fig. 130) the *intestinal tract* of an example of *Breviceps gibbosus*, which has been opened up for the greater part of its length. The general aspect of the intestine of this species is very like that of the species which I formerly described*, and it can be divided into precisely the same regions. In the present species the duodenum measured 7 mm. in length; the ensuing wide region of the intestine was double this length, viz. 14 mm.; the long narrow terminal region, which opens into the colon, was again double the length of the preceding region and measured 29 mm. The short duodenum shows externally a division into small and approximately equal rounded areas. This appearance was also seen internally where the folds of mucous membrane constitute a network.

In the wide region of this gut the folds are circular and precisely as I have described them in the other species. In the terminal region of the small intestine the folds are entirely longitudinal, and there is a transitional area which is also indicated in the accompanying text-figure.

* P. Z. S. 1908, p. 32, text-fig. 10.

The stomach has much the same character as in the other species; but the contents were quite different. In the stomach described here were the remains of a largish beetle and an entire and quite large beetle larva and some other insects.

Text-fig. 130.



Alimentary tract of *Breviceps gibbosus* with the greater part of the small intestine laid open.

A-D. Portions of the different regions of the intestine more highly magnified.
Co. Colon, cut short. H. Heart. L. Liver. St. Stomach.

The text-figure to which I have referred in describing the intestinal canal (text-fig. 130) also shows the liver, which is a little different from that of the other species of *Breviceps* whose anatomy has been described by myself. The heart is not at all

covered by the liver in the species *Breviceps gibbosus*. There is, however, as I have illustrated by figures*, some individual difference in the liver in this genus.

§ On certain Characters of the Skeleton.

I did not notice particularly the sternum of the other species of *Breviceps*; in *B. gibbosus* the form is not at all as it is figured by Parker in his 'Monograph of the Shoulder-Girdle'†, nor is it like the woodcut given by Boulenger in the 'Catalogue'‡. The cartilaginous plate is much more important than would be gathered from those figures, and expands laterally into a curved and thinnish process. It is, in fact, very like the sternum of *Discoglossus pictus* as figured by Boulenger§.

Two other features in the skeleton of this frog were commented upon by myself in the earlier account of the anatomy of this genus. I naturally endeavoured to ascertain if those peculiarities were to be found in *Breviceps gibbosus*, and I find that the species which forms the subject of the present notes has the plate of cartilage lying upon the expanded sacral transverse process, and that the anterior cornua of the hyoid are perforated in exactly the same fashion||. I need not give a more prolonged description of these peculiarities, which appear to be identical in the two species.

§ On certain Muscles.

Many of the muscular peculiarities of the species described in my earlier paper occur also in the species now under consideration. It is, perhaps, important to enumerate such of these as I have verified, in order to confirm them—for they are unusual—and also in order to point out that they are apparently characteristic of this genus or at least of more than one species. I shall not, however, give a long description of them. In the first place, the *latissimus dorsi* (see text-fig. 131), not a very large muscle, is completely covered over by the double sheet of the *obliquus*. There is also no trace of the posterior part of the *depressor mandibulae*. I did not note in my paper whether the cephalic portion of this muscle was present. I find that it is present in *B. gibbosus*. In the present specimens also the suprascapula is largely exposed anteriorly when the skin is removed, on account of the absence of the posterior part of the muscle just referred to. It is covered, however, by a tough fascia. Furthermore, the dorsal muscle of the suprascapula, the *infraspinatus*, is quite visible without removing any other of the dorsal muscles.

The *rectus abdominis* is nearly as in *Breviceps* sp., where I have figured it. In *B. gibbosus* I could find one superficial

* P. Z. S. 1908, p. 30, text-fig. 8.

† Pl. vii. fig. 9.

‡ 'Catalogue of Batrachia Salientia,' 1882, p. 176.

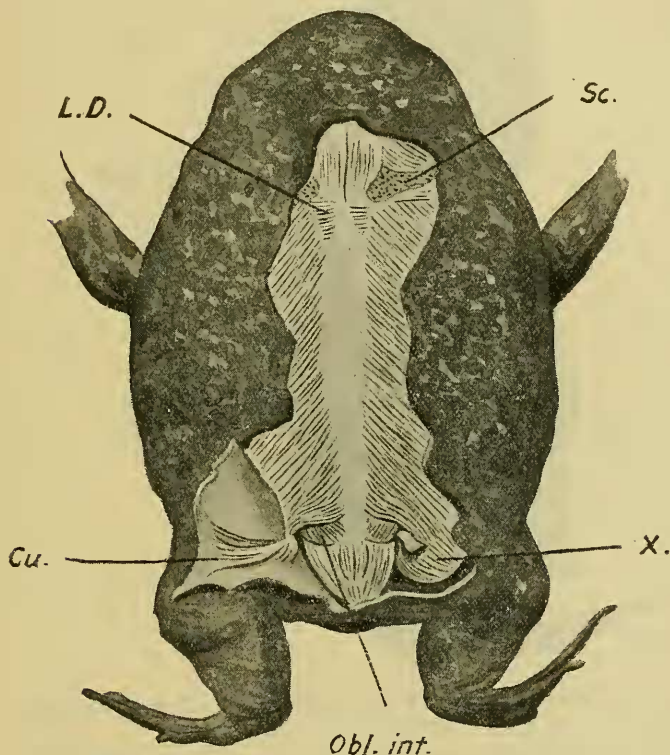
§ 'Tailless Batrachia of Europe,' Ray Soc. Publ. 1897, vol. i. p. 40.

|| Cf. P. Z. S. 1908, p. 12, text-fig. 2.

inscriptio tendinea*, behind the origin of the *pectoralis abdominalis*. This muscle arose a little in front of the first and only visible inscriptio tendinea.

The other abdominal muscles, q. s. *omo-abdominal*, *hyo-abdominal*, and *obliquus internus*, are quite as I have described them in my former paper, except that the *hyo-abdominal* seems to be rather larger. This muscle passes under the lateral process of the sternum, i. e. dorsally to it, and would thus appear to belong to the obliquus internus sheet, and not, as I formerly suggested, to the obliquus externus.

Text-fig. 131.



Breviceps gibbosus, from the dorsal surface, partly dissected.

Cu. Cutaneous muscle. *L.D.* Latissimus dorsi. *Obl.int.* Obliquus internus.

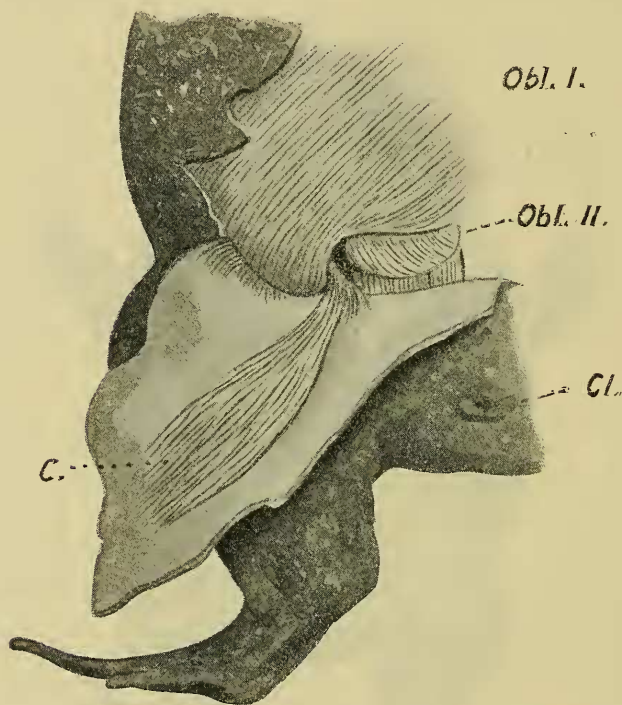
Sc. Scapula. *x.* Slight bulge of dorsal musculature referred to in text.

The *obliquus externus* is rather different from that of the species of my former description. The fascia dorsalis is quite obvious, and the origin of the muscle is thus some way removed from the

* *Loc. cit.* p. 23, text-fig. 5

middle line of the back (see text-fig. 131). Its fibres run obliquely backwards and are massed into coarse strands at the origin of the muscle. The origin of this muscle extends further back than was formerly described, and covers the obliquus internus until very near to the end of the line of origin of the latter. The obliquus internus only becomes superficial for a very short distance posteriorly. These differences may be seen on a comparison of

Text-fig. 132.



An enlarged view of a portion of text-fig. 131, to show absence of diverticulum of body-cavity overlying thigh.

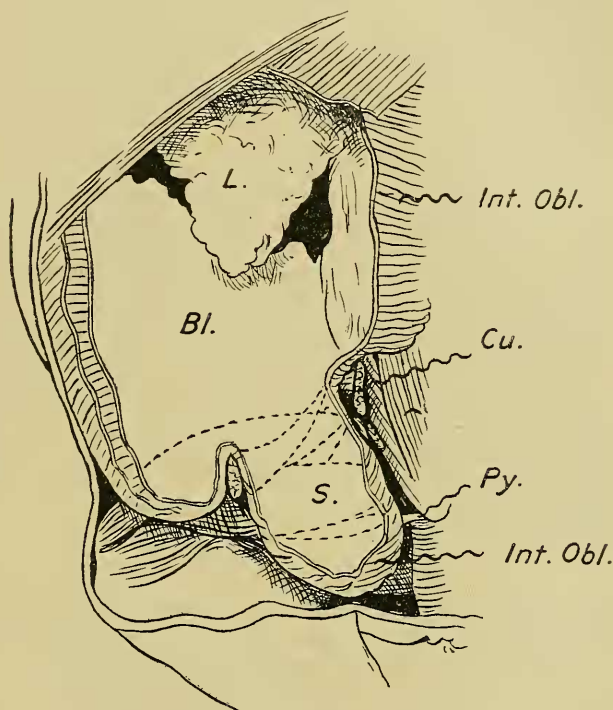
C. Cutaneous muscle. *Cl.* Cloacal aperture. *Obl.i.* Obliquus externus.
Obl.ii. Obliquus internus.

text-fig. 131, p. 409, of the present communication, with text-fig. 4, p. 20, of my paper on the other *Breviceps*. I am able to confirm the statements about the latter species, so far as the points at issue are concerned, by the examination of a specimen given by me to the Royal College of Surgeons, and dissected by Mr. Burne.

The aforesaid figure (text-fig. 131), which is to be compared

with text-fig. 4 of my previous paper upon this genus, not only shows the differences in the oblique muscles already referred to, but indicates the nearly total absence of anything comparable to those structures which I identified in my former paper with very much enlarged lymph hearts. There is, indeed, a slight bulge of the abdominal wall posteriorly, but it does not extend over the dorsal surface of the thigh; nor is this bulging at all detached from the

Text-fig. 133.



Copy of a drawing by Mr. R. H. Burne, illustrative of certain parts in the anatomy of *Breviceps* sp. referred to in the text.

Bl. Body-cavity. *Cu.* Cutaneous muscle. *Int.Obl.* Obliquus internus. *L.* Lung.
Py. Pyriformis. *S.* Diverticulum of body-cavity overlying thigh.

The muscles of the thigh are indicated by dotted lines.

abdominal wall. It will be easily seen from an inspection of text-figure 132 that an extension of the body-cavity on to the dorsal surface of the thigh is impossible in the present species. For, as will be seen in the last figure referred to, a ridge of cutaneous muscle ties the commencement of the thigh to the skin and thus

effectually prevents any hernia-like outpushing of the abdominal cavity backwards. There is thus an important difference between the species with which I am now concerned and that which formed the subject of my earlier paper.

With reference to the latter species, I am able, through the kindness of Mr. R. H. Burne, to submit a drawing of a dissection made by that anatomist on a specimen of the toad which I presented to the Royal College of Surgeons. Having also seen the actual dissection, I am obliged to admit that Mr. Burne has proved that my former account of this region of the body was not correct in every detail. Mr. Burne has ascertained and has demonstrated to me that the structure which I termed a "lymph heart" is a diverticulum of the body-cavity, lying, however, on the leg, as is clearly shown in the accompanying drawing (text-fig. 133, p. 411). This connection was so wide that the bladder had floated into the diverticulum.

I feel convinced, however, that the communication was not so wide in the larger female example dissected and figured by myself. For the diverticulum was easily detached from the surrounding structures, a fact which argues some independence, as it would seem at least to show that the orifice into the general thoraco-abdominal cavity can contract. Furthermore, the arrangement of the oblique muscles in the region is rather different from what may be seen anteriorly. Thus we have, certainly in this species, a specialized portion of the thoraco-abdominal cavity (which is recognisable, but much less prominent, in *Breviceps gibbosus*) extending over the dorsal surface of the thigh. It is not, however, I now admit, possible, in the present state of our knowledge, to speak of this as a "lymph heart." I propose, however, to defer any further consideration of this subject until more facts have been accumulated.

21. On the Spermatophores in Earthworms of the Genus *Pheretima* (= *Perichaeta*). By FRANK E. BEDDARD, M.A., F.R.S., F.Z.S., Prosector to the Society.

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(Text-figures 134-136.)

I believe that there is no account of the spermatophores in this genus of Earthworms; and at least there has not been, to my knowledge, anything more than the briefest reference to their occurrence. It might be expected from analogy that this genus, like so many others, possessed this means of impregnation; but I can recall no figures of such structures. Even supposing that I have involuntarily ignored such an account, it is worth while to add something more to the subject, which cannot be well known.